The Leonardo da Vinci pilot project AVOCAAD (Added Value of Computer Aided Architectural Design) aims to innovate the use of computers in architecture. Here, new course materials and structures are developed. Focus is on new unusual ways to use software in Architecture. In this paper, we first describe the context using the general AVOCAAD statement. In order to give structure to the developed materials, a scheme was developed. This AVOCAAD scheme is given and described. Some examples of concrete course materials are given in the next section. In order to innovate in the architectural curriculum as well as in design offices, these materials will be
available through the Internet. Hereto, a web-structure for the exercises was developed. Some experience and conclusions are given in the final section.

**Keywords:** AVOCAAD, CAAD, creativity, innovation, exercise materials

**Introduction**

The Leonardo da Vinci pilot project AVOCAAD (Added Value of Computer Aided Architectural Design) aims to innovate the use of computers in architecture. Hereto, new course materials and structures are developed. Focus is on new unusual ways to use software in Architecture. The projects wants to benefit from the experiences in universities as well as in architectural design offices. The course materials developed will be used in the normal education of architects as well as for post-graduate education, continuous education and training-on-the-job of architects working in an office. As this last category graduated some years ago and there is now much more experience in the ‘upstream’ use of computers, especially for them, an incentive towards stimulating more creative use of computers is necessary.

**The AVOCAAD statement**

The original statement of the AVOCAAD project as it was also included in the proceedings of the 1st AVOCAAD conference (J. Verbeke et al. (ed.), 1997) is as follows:

«Normally, a long and tedious design process proceeds the realisation of an architectural object. During this design process, the initial ideas and concepts of the architect crystallise out in a realisable form. The recent new technologies, the availability of computers and software which become cheaper and more user friendly, imply that (even small and medium) design offices start using CAAD (Computer Aided Architectural Design). This has an important impact on the design process which is currently under major change. CAAD offers a lot of new possibilities and there is an increasing number of examples showing us this new technologies support and change the design process in a positive way. Nevertheless, we see an important part of the design offices is not using these new possibilities. They are using CAAD only for producing plans. Acting in this way, these offices do not gain any added value of CAAD. Although the new technologies offer a lot of new techniques and can have a positive impact on the design process, we see a lot of architects who get confronted with these new media, react in a negative way. So, it is clear new impulses are needed in order to develop the added value of CAAD to the design process and to make this positive impact clear to the architects.

In order to realise the previous goal and to react to the rapid changes in the field, it is necessary to develop new training methods, new course contents and new training material. This material has to underline the added value of CAAD to the design process. This will augment training quality and the meaning and position of CAAD in the curriculum. It will also give maximal chances to CAAD in the future. In a second phase we see a positive impact of the designing offices and the architectural Institutes on the further development of CAAD. The new training methods, new course contents and new training materials will make the anticipation to future developments and faster innovations possible.

This can be realised in the following way. The project will benefit from the practical training program AVOCAAD-stage. The experiences will be brought together in order to develop a new vision on the creative use of CAAD. New course material will be the concrete result. This will be the start of new training and in-service training oriented towards the added value of CAAD. As a final period we see training periods in design offices during which the new developed vision and training material will be confronted with the design practice.

By incorporating this new material in the curriculum, by integrating it in a short intensive course (as part of the continuous education as young architects who finished their studies in the near past have not yet gained this knowledge) and by making it available though the Internet (for training-on-the-job), we hope to reach a maximal effect.

Because of the complexity and the fast evolution, it is clear this project can only be realised by a co-operation of different partners all over Europe: design offices, software specialists and universities. We want to bring together the variety of experiences and ideas in Europe in order to incorporate the added value of CAAD as well as possible.»
Within this context a scheme was developed which positions exercises and courses depending on their intentions and content. This scheme is described in the next section. Course materials and exercises are being developed at the same time and some examples are given below. Every material is placed on a web-site which is under development and which will function in an interactive way. This is further developed in the last section.

The AVOCAAD scheme

Nowadays there is no doubt that Information and Communication Technology (ICT) is of increasing importance in the construction industry and especially in architectural design. During the last one or two decades CAAD-systems have evolved from simple 2D drafting tools to complex 3D design tools. The latest CAAD-systems are based on product modeling concepts using the advantages of object oriented techniques. They offer a much better connection to various building performance calculation and evaluation tools in a more collaborative way. Also presentation has been dramatically improved. Wire frames and flat shaded images are replaced by very realistic interactive Virtual Reality models giving both clients as well as designers (although not every designer will admit this) a much better understanding of the consequences of design decisions.

Although major enhancements were made since the early CAAD-systems, there is still a long way to go before CAAD systems will meet the requirements of the virtual design studio as described by Mitchell. According to him, «In the near future, virtual design organisations will be supported by virtual design studios-networked facilities that provide the geographically distributed participants in a design project with access to the organisation’s databases and computational resources, efficient messaging and data exchange, and sophisticated video teleconferencing, in highly integrated fashion.» [http://alberti.mit.edu/dsof/research/creative_design.html].

For most of us, these statements sound familiar. They are mentioned here explicitly because it is important to understand that the definition and elaboration of a CAAD-curriculum is an ongoing process of re-evaluation and improvement of goals, contents and means.

One of the initial steps dealing with the formulation of a new CAAD-curriculum was the exploration by the AVOCAAD-team of several CAAD-courses given at their and other universities. During the analyses of the results, the team was confronted with the problem how to classify all these different courses. The basic understanding of a curriculum is that it should be a set of more or less coherent courses. So the question is what criteria to use to classify the different modules in such a way that a coherent set can be defined.

During the evaluation two general observations could be made. The first observation was that a part of the courses were concentrating on technical computer issues. They address CAD fundamentals, MultiMedia techniques and computer hardware. In general these courses aim to achieve practical skills and technological insight, the ‘Computer Aided’ aspects of CAAD. The remaining other part focuses on architectural design. Here, issues like basic design concepts and design theories or methods are lectured, the ‘Architectural Design’ aspects of CAAD.

The second observation was that some courses are dealing with declarative and procedural knowledge and related tools while others look at concepts and tools that support creativity and intuition.

Both observations resulted in a scheme with two orthogonal axes, bounded by a circle as shown in figure 1. Every lecturer was asked to position his course in this scheme by placing a dot and a small description of the course.

An other advantage of using the scheme on the Internet is when a gap of a certain type of courses is detected. In such a case, the Internet can be used to address other universities with the request for the missing course.
The next step is concerned with the identification of different curriculum subprograms, each with a pre-defined goal. For example, suppose a certain subprogram wants to give students more knowledge, insight and practical experience with using Virtual Reality in design. Such subprogram could be realized by picking a set of courses and do some fine tuning. The quality of such a subprogram and whether it is achievable depends highly on the number and quality of the available courses. Fortunately more and more courses become available on the Internet.

Exercise examples

In this section we give several examples of exercises developed within the above context. All exercises are formulated following a predefined structure: description (giving some background and context information), goals, required skills, required software, exercise (the detailed exercise description) and results (the format in which the answer is requested).

These examples should give the reader of this paper a good feeling of what is intended and show the way the project is aiming at. More materials are currently developed and tested. On the new materials will be reported in the future.

Figure 1: The AVOCAAD Scheme.

Example 1: Scale modelling

Description: Architects starting designing on computers regularly have problems with scale. Designing a real project with real dimensions in a virtual environment is confusing because of the lack of a reference.

This exercise confronts you with this 'scale problem' by offering a virtual environment in which a real project has to be designed. The scale will be checked by reference objects such as humans and viewpoints at pedestrian level.

Goal: To become aware of the dimensioning of real objects in a virtual environment and to become familiar with the basic skills of 3D modeller and VRML.

Required skills: Basic 3D modelling and VRML authoring.

Required Software: A simple 3D modelling or VRML authoring tool.

Exercise: Create a human forum in the given urban environment. Use the 'building blocks' that are given by the 2 different sized toolboxes. You can copy, move and rotate this elements, but resizing, rescaling and adding colours and textures is not allowed. Add some human reference objects and define minimum 3 viewpoints at pedestrian level (or use the predefined ones).
**Result:** One VRML world (in VRML 2.0 format) with the 3 viewpoints defined in it.

**Example 2: Image editing towards exiting couples**

**Description:** Image editing software makes it possible to change visual pictures, photographs,... It is possible to change colours and to filter out colours of parts of a picture. Moreover, it is also possible to change the information in a picture drastically by changing the resolution of pixels, or by using one of the many available filters. These and other operations create out of an initial picture new images.

**Goal:** Learn and discover (basic) commands of an image editing software. Discover the power of creative image editing and try to give a picture an added value by using a computer. Discover the limits of the available possibilities, explore them and possible create innovative use.

**Required skills:** Basic knowledge on the working of image editing software.

**Required software:** An image editing software (Adobe Photoshop, CorelPaint,...).

**Exercise:** Create new images from three chosen pictures (scanned, from the web, newly created,...) by applying filters, effects and/or transformations. In each case, the two images together (original and edited) have to express an idea or concept. The result needs to have an added value compared with the initial individual picture. The answer consists of 3 sets of pictures.

**Result:** Three or more sets of two images (the original and the modified) in GIF-format which form together an exiting duo.

**Example 3: Space-Geometry**

**Description:** This exercise enables to explore spatial and geometric relationships between elements, parts, volumes of the designed abstract composition. The aim is to achieve a form, which represents certain architectural space quality. The forms are composed with the set of primitives - cubes, spheres,... They are juxtaposed, moved, rotated, scaled in order to achieve the acceptable or desired spatial, aesthetic expression. In a common sense it a game with simplest 3 dimensional geometrical forms.
**Goal:** To create an environment, which enables possibly easiest formal and spatial exploration of 3-dimensional forms interrelations; to enable students get an easy and effective modelling possibility; to overcome the time and material limitations of typical models making; to explore the abstract computer modelling as a useful activity in the conceptual stage of architectural design.

**Required skills:** Creation and basic operations with 3 dimensional forms. Additionally, options enabling simple renderings, as lights definition, are useful. However, they can be learned as one of the steps following the basic modelling.

**Required software:** Autodesk 3D Studio release 4 - mainly its module 3D Editor. However, every 3D modelling package can be used to proceed this exercise. It is recommended that the software enables as much intuitive as possible way of using its routines.
Result: The result of the exercise is a set of models made by each student as well as rendered images presenting them. When the students become more aware of the software possibilities, the more advanced modelling is possible, for example in exploring colour and texture relations. The most important result is the students’ experience of form awareness achieved after making a number of different models in a relatively short time.

As a next step it is possible to prepare a more advanced exercises, where students are to do forms of required quality - dynamic, static, massive, monumental, etc.

Figure 4: Space-Geometry

Figure 5: Space-Geometry.
Example 4: The sitting (computer) man

*Description:* Man is the central figure for whom we design. Often, dimensions are related directly to man and his activities, such as sitting, working, moving, resting, looking, etc. Posture and possible gestures lead the design when decisions have to be made about things such as chairs, tables, corridors, beds, windows, etc. It is necessary therefore, to gain insight in the relation between the dimensions of the human body, its range of movements and scope of action, and elements of the design the architect is working on.

This exercise shows you how functional dimensions can be acquired from the human body by asking you to design a chair for a computer-drawn human figure. The chair should relate to the proportions and dimensions of a sitting person.

*Goal:* To gain insight in the relation between the dimensions of the human figure and built elements. To learn the basic proportions and dimensions of the human figure. To learn a number of basic computer skills: opening a drawing file (AutoCAD command: Open); using of toolbars (Toolbars); using a module (Snap); using libraries (Insert); decomposing a predefined element (Explode); selecting objects; moving objects (Move); rotating objects (Rotate); removing objects (Erase); drawing lines (Line); drawing multiple lines (Pline); typing text (Text); using the zoom-options (Zoom); using horizontal and vertical dimensioning (Dimensioning); plotting a drawing (Print).

*Required skills:* No special skills required.

![Example image of student work.](image)

*Required software:* The exercise is developed for AutoCAD. A file for the drawing with predefined snap and grid is provided for. Predefined human figures (MARIONET) are provided in pull-down menus the measures of which correspond with the snap and grid of the drawing file.

*Exercise:* Draw a sitting human figure within a frame. Show dimensions of the human figure that you think are relevant for designing a chair. Make sure the layout of the drawing is looking good.

*Result:* A drawing on A4 of a sitting person, with dimensions.

Example 5: Variations in a space

*Description:* When an architect has established basic dimensions and shape of a space, this usually has been checked for functionality by placing furniture and such in the plan representation of the space. Usually, such a
configuration of furniture in the space is specific for the design brief (where the patron has asked for a specific interior in a space). However, during the lifetime of use of a space, inhabitants often change the interior to meet new user demands, when furniture is replaced, etc. Can the space accommodate such change or is it really only optimised for one particular configuration; in other words: how much variation does it allow?

This exercise shows how with the use of the computer, it is possible to generate many different interiors in a given space, thus checking the range of possibilities of a space to accommodate change.

**Goal:** To gain insight in the several ways occupants use a space during their time they are living in a space. To gain skill in the systematic analysis of possible uses of spaces that are designer by yourself or others. Basic computer skills that are learned are: using libraries (Insert); selecting objects; moving objects (Move); rotating objects (Rotate); removing objects (Erase); drawing lines (Line); drawing multiple lines (Pline); plotting a drawing (Print).

**Required skills:** Basic design skills in order to interpret a given space and to make arrangements of furniture that make sense.

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**Figure 7: Interior design of the house in AutoCAD.**

**Required software:** The exercise is developed for AutoCAD and is number six in a series of exercises. In previous exercises, already a space has been designed in AutoCAD with one particular furnishings. This file is now used for exploring many different furnishings in that space.

**Exercise:** Make an analysis of the possible furnishings of a space by establishing essentially different (not just moving a chair 30 cm or such) configurations of furnishings that can be realised for a family with two children.

**Result:** An AutoCAD file with the drawings of essentially different configurations. Corresponding A4 plots of the drawings.

**Example 6: Authoring the architect’s visual presentations.**

**Description:** Working with modelling CAAD software the architect produces a lot of images. Most of the time the images, Quicktime movies and Quicktime VR’s are deleted after a short glance. Considering the time even the fastest computer takes to do those renderings it must be »economic« to make use of some of these images and at
least put them in an archive. Occasional presentations which are going to be more frequently asked for by the other actors of the building process can then be made by using images from the archive instead of being produced on the screen while the spectator is waiting.

This exercise will show some ideas from multimedia techniques which can be used by architects. It also points out that a lot of inspiration can be collected from the advertising specialists and video producers, though the architect’s use of visual presentations has a more direct goal for interaction with clients etc.

Goal: To make the students aware of the value of developing the production of images, to store them and to use them in efficient presentations using the possibilities of the computer medium.

Required skills: Basic 3D modelling and image processing. Experience from examples of presentations on the Internet and on demo-CD’s.

Required software: CAAD modelling software, graphics processing software like Photoshop and HTML authoring tools.

Exercise: Create an image database from an earlier modelled project by using the ordinary file system of the computer system. Start by planning which facts and »advantages» of the project to describe and visualise for a presentation. Make a systematic structure for naming and sorting the images. Make a storyboard on a presentation for the client (which usually is not the same as you would do to present for a professor!). Parallels between the architect’s presentation and what you can see on for instance TV are drawn by the teachers or in the instruction material.

Result: A start for a fairly systematic image database and a skeleton of a visual presentation to be developed and used later on in some more »real» project.

Figure 8: Example of a student’s work. Wood is the theme of the project and wood is the metaphor used for the buttons
Example 7: Interactive communication links with «buttons».

*Description:* One of the essential means for orientation and interaction with an image database is the use of linkage by «buttons». There is a big difference between an interface to be used by the author himself and the one to be used by someone else! The metaphor has to be logical and understandable. Buttons must be easy to discover and operate and the functions must be understandable. A smart look is nice in many ways but not to every extent. There are lots of good and bad examples to be found all over the Internet and on demo-CD’s.

This exercise will give some experience on possibilities and difficulties to design buttons as the operating part of a visual interface to an image database. The interface is the navigation tool and is to be planned accordingly. From a technical point some examples of solutions are given. From a cognition viewpoint an awareness of the importance of design consequence is to be awoken.

*Goal:* To give the students some good examples on how to create a navigation system in an image database by using buttons.

*Required skills:* Basic knowledge of HTML authoring tools, how to use a simple «Paint» program and experiences from surfing on the Internet.

*Required software:* HTML authoring tool, access to the Internet and a simple pixelgraphics painting tool.

*Exercise:* We start by collecting examples on «buttons» from the Internet. Sort them in different categories and describe some basic structures for a navigation system. Design a layout of the skeleton of a CAAD-project presentation on the Internet using maximum two kinds of «buttons» with relations to a chosen metaphor for the interface.

*Result:* An example of an interface to be used and developed further on. It would be an advantage to be able to share the examples within a group of students to be aware of the richness of possibilities.

Example 8: Horizontal stabilisation of multi-storey buildings

*Description:* This exercise intends to produce understanding of the nature of lateral loads and their influence on the dimensioning of the bearing elements. The design-process works interactively between architect and engineers as planning-partners. This sometimes results in a time- and energy-consuming matter, if there is a lack of common knowledge in sensitive fields.

Many architects have difficulties with the useful arrangement and the affordable number of stiffening walls in order to provide satisfying horizontal stabilisation.

Horizontal stabilisation is a very sensitive matter - especially if the dimensioning of the bearing elements is involved. Frequently the architect dreams of extremely slender columns and refuses to understand why the structural engineer insists on columns with large sections.

*Goal:* To get insights into the problems of horizontal stabilisation of multi-storey buildings as to the arrangement of walls and to the dimensioning of columns.

*Required skills:* Basic knowledge of computer use (how to go through pages of a text-system, which should be able to handle images) and a little advanced knowledge of structural analysis for architects.

*Required Software:* A simple text-system, capable of implanting images.

*Exercise:* Given is a 3-storey building, 6x6,0 = 36,0 m in length, 2x7,20 = 14,40 m in width and 3x3,50 = 10,50 m in height. The bearing structure consists of slabs, columns and walls.

Give a set of proposals to stabilise the building by using only few walls. Give an estimation of the dimensioning of the columns with only vertical forces. Columns may be concrete or steel, consider the columns in the first floor and in the top floor.

If we remove the walls, the columns have to take also the horizontal loads. Try to estimate the influence on the dimensioning of the columns. Try first and then go to the support pages.

At last try a five-storey building, applying the same questions.
The AVOCAAD exercise web-site

The main goal of the AVOCAAD Pilot Project Website is to provide a tool for architects in practice and architectural students to discover the added value of Computer Aided Architectural Design. The exercises developed formulate a specific architectural problem to the ‘user’, focused on the creative use of computers. The user has to design or create the ‘object or solution’ asked, not by following a prescribed path, but influenced by his personal ideas and background and assisted by the knowledge and experiences he extracts from the AVOCAAD knowledge base. Every ‘user’ will track his own path through the exercises and the related information (both internal AVOCAAD topics and hyper-linked external documentation). The AVOCAAD exercises aim to express the added value of CAAD in a general software independent way and do not have the intention to be a basic ‘drafting’ course. Yet, the reference manuals of software could be linked to the scheme on a specific layer, providing the user with the information when he might need it at a certain point resolving the exercise.

The exercises, AVOCAAD topics and external links are visualised as coloured dots on different layers on the AVOCAAD Scheme. The dot’s position on the scheme represents the kind of information it contains. When moving over a specific dot, the title of the exercise, topic or link appears. Clicking it displays the underlying information.

The AVOCAAD Scheme is currently the main entrance to the topics and exercises, but in future, the material will be available through different interfaces, which will be presented in a next paper.

When you choose to make an exercise and you hit its dot on the scheme, you will arrive at the main exercise page. This contains the description (explaining the general context), the goal, the required skills, the required software (always the kind of software, rather than a specific package), the explanation of the exercise itself and what kind of result you should reach at the end. This main page has also some links that may be useful for anyone who makes the exercise: to related topics (AVOCAAD topics as well as external hyperlinks), to exercises that have the same interest or that are somehow related and to the results of other people that made the same exercise. In addition, four indicator bars give an impression on the time load, the required computer skills, the required design skills and the difficulty level of the exercise.

After finishing the exercise, the result has to be submitted to the web-site, as well as some explanation on the basic idea of your result and the path followed to come to it, where it will be included in ‘other peoples results’. Now other ‘users’ who have finished the same exercise can provide comments on your result and you can discuss
other’s results. This provides a lot of reflection on the exercise you made and the path you followed through the exercise.

In this way, the AVOCAAD web-site will become a discussion forum to exchange experiences and ideas in the field of the creative use of computers in Architecture, useful both for architectural students and architects in practice.

Figure 10: example of the use of the AVOCAAD web-site.

Conclusions

The AVOCAAD group meets regularly. Due to intense and frequent discussions the meetings, the current scheme and exercise materials were developed. Moreover, communication between the partners is taking place by e-mail and through the announcements on web-pages.

Experiments with students show they work very enthusiastically on the proposed exercises. The first results show very interesting answers of the students.

The scheme and the availability of exercises on the web-site provide a powerful tool for further development of course materials. The interactive exercise web-pages provide a forum for discussion and exchange of experience and ideas towards the creative use of computers in architecture.

It is the intention of the partners to develop more materials and to test them with architects in practice and with different groups of students. Moreover, action will be taken towards design offices to introduce the exercises as a way to innovate and to stimulate a different use of software for architecture.
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References